TIGER MOTH TYPE RATING

This document was originally written by David Phillips. He has asked for feedback, in particular he would be keen to hear from people who grew up with Tigers, as they probably have clearer and purer recollections of the original way of doing things.

So, if you have anything to offer on the subject please contact Dave at david@jdphillips.co.nz
or 021 384 225.

This first section is focused on the basics of flying a Tiger Moth, a subsequent section will look at flying aerobatics in the Tiger. Four of the major differences from typical light aircraft that the Tiger Moth trainee has to adapt to are:

1. Restricted and offset view, especially on the ground. You can't see anything directly ahead, and when you look out the side, your best "straight ahead reference point" will be slightly angularly offset, making it difficult to assess whether you are tracking down the centreline of the runway during takeoff, or are drifting off to one side or the other;
2. An inhospitable cockpit environment. It can be cold, draughty, lonely, noisy and somewhat uncomfortable;
3. Very poor control harmony. The rudder in particular needs a lot more attention; and,
4. The Tiger Moth is very sensitive to wind, particularly when it is above 10 kts.

As with any activity, it all becomes "normal" and "familiar" if you do enough of it. You can accelerate this process by spending a little time ensuring you are comfortable. Make sure you get the right size cushion, windproof attire, scarf, goggles, comfortable helmet, ideal volume and squelch settings, intercom that works, etc.

Also give the instructor adequate feedback as you have a better understanding of "what you understand" than the instructor does. Keep them in the picture. If you want to do more of some stuff and less of others, then let them know. It is tough for the instructor to read your body language from their front seat. In particular, if you have had enough or want a break, let them know. The aim is enjoyment and reward, if you are not achieving this, then change tack.

Ground Handling

To move the aircraft, lift the tail by the tailplane strut, gripping as close as possible to the fuselage. The aircraft will be neutrally balanced when the skid is at about your head height. If you lift it any higher and let it go it will probably tip onto its nose.

The easiest way to move the Tiger is with ONE person lifting the tail (to about shoulder height supporting little weight) with someone else pushing on the rear (or front) of one of the wing walks. Because the balance changes quickly as the tail is raised, if two people lift the tail they nearly always end up in opposition to each other, with one person lifting up and the other pulling down.

Whilst you've got the tail up in the air, have a good look at and play with rudder/tailskid "interconnect".

Preflight Inspection

Before your first preflight your instructor should walk around the aircraft with you seated in the back cockpit so that you can find the reference points ahead and for the three-point attitude. They should then lift the tail to the takeoff attitude. Your instructor may also put some masking tape over the bottom half of the turn indicator, so that all you can see is the top half, which is the slip indicator (ball).

Check that the fuel is on and that the magneto switches are both OFF, in both the rear and front cockpits. Then walk clockwise around the aircraft from the cockpit. Check the flying wire tension on the left wing, note aileron differential. Check the oil quantity is 2/3 full or more. Check the engine from the left side - mag wiring, prop not loose, spinner tight. Check the engine from the right side - mag wiring, exhaust manifold nuts/gaskets, prime the carb, exhaust pipe security. Then climb up on the cowl for a fuel contents check and a check of the top surface of the wings. Check the flying wire tension on the right wing. Check the rear locker contents, the tailplane security and that the tail fin main spar is not cracked. In general check that there are no wrinkles in the fabric which may suggest deformation or breakage underneath.

Engine Starting

Ensure the aircraft is in a suitable area. It is vital to ensure that the chocks are in position, that the throttle is closed, and the magneto switches are OFF. Hold the stick hard back.

The ground assistant is “in charge” of the whole process and calls the shots.

After priming the engine, the ground assistant should pull the propeller through four (4) times (always treating the prop as live!). Then they will call for you to open the throttle fully and the ground assistant will then pull the propeller backwards through eight (8) compressions.

When the ground assistant is ready they will call “Throttle closed”, “throttle set” and “Contact”. You should then close the throttle fully and then reset the throttle to 3/16 of an inch forward of the fully closed position and switch ON the impulse magneto (No 2) and repeat the commands. The pilot should check you have the stick hard back at this point, to cater for the possibility that the throttle linkage has broken and the engine is stuck on full throttle.

The ground assistant should then carefully swing the propeller through the compression stroke to start the engine.

Once the engine has started switch on No 1 magneto and monitor the oil pressure rise.

Warm the engine at 800 to 1,000 rpm to ensure smooth running, for at least four (4) minutes in the summer and for at least eight (8) minutes in the winter.

Check the magnetos by carrying out a dead cut check at idle.

Carry out the engine run-up checks. Bring the engine up to 1,600 rpm and carry out a magneto check. Then briefly apply full throttle to check the static rpm is 1,950 to 2,100 rpm. Finally check that the engine idles with throttle closed at between 600 and 700 rpm.

Taxiing

In theory hold the stick hard back to avoid a nose over. However, neutral is probably better as this gives less pressure on skid which leads to less turf damage. Full forward stick and a blast of power will lift the tail. Once moving, the only "brake" you have is the tailskid. With soft ground it works well but with hard ground the tailskid slides.

The Tiger is steered on the ground by a combination of "tailskid steering" and slipstream against rudder. If you are taxying down wind, you may get away with skid steering alone. If this is inadequate, you will need more slipstream, which means more power and therefore speed, in a situation where it is already not so easy to stop.

Taxying downwind in more than about 10 knots of wind will be difficult directionally and it will also be difficult to stop. It may be impossible to stop on hard smooth ground with an engine that won't idle below 600 rpm. With between 10 and 15 knots (or so) of tailwind you will need wingtip assistance to taxi downwind. On soft grass you can deal with stronger winds as the skid digs in and provides drag and steerage, and you can use more power (slipstream) without accelerating.

On short baked grass though e.g. at Napier or Nelson in the middle of summer, steering and even stopping, can be difficult even in light winds.

If you start losing directional control downwind your choices are:

1. Stop. When stopped, a large blast of power and full rudder may get you pointed the right way again, hopefully without gaining too much speed;
2. More power. This is okay if space is unlimited, but remember you now have a lot of slowing down to do which requires a closed throttle and no slipstream over the rudder; or,
3. Shut down and roll to a stop.

Up elevator (full back stick) digs the tailskid in for better stopping, which is effective during the landing roll whilst there is still some airflow over the tailplane.

While taxiing, weave for forward visibility. The rudder has more travel than the "steerable" tailskid. At low speed and low power settings the tailskid will turn you rather like a steerable tail wheel, but with wide turn radius.

You can turn much more tightly (especially to the right) with a blast of power against full rudder. To do this hold the stick forward of neutral to allow the tailskid to slide sideways.

The problem is will this increase your speed and if you were trying to tighten the turn due to a confined space, and you find the turn is still not tight enough and you may now be going too fast to stop.

The solution is more power (i.e. more slipstream, to make the rudder bite) but this also means more speed, and a potentially more violent collision. So, decide early whether or not you can do it. If not STOP, get out and lift the tail around.

If a collision is imminent turn the magneto switches OFF. It will slow a little better with no thrust at all.

When using a liberal blast of power from low speed to achieve a tight corner you can easily get into a situation where the momentum of the back end swinging around will tighten the turn still further, like a mild ground loop. This can be used to your advantage for a very tight turn, as long as it doesn't get out of hand. Again, push the stick forward to reduce weight on the tailskid, which will allow it to slide sideways easily and dramatically reduce the turn radius.

Wind

It may be helpful to think of the Tiger Moth as two different aircraft types. One when the wind is less than 10 kts, and another when the wind is greater than 10 kts.

Obviously 10 kts is an arbitrary demarcation, which can be moved a little up or down dependant on other factors such as ground surface type (seal, grass, hard earth, slope etc.) and wind direction, gustiness etc. But you can say with some certainty that if the wind is 5 kts or below, the Tiger is docile and forgiving, whereas at 15 kts and above it is definitely growing horns.

In the initial Tiger era (1920's and 30's) aircraft were often called "kites" and for a very good reason. The wind should be at the forefront of your mind whenever you are flying - and especially when you are taxiing - a Tiger. Wind above 15 kts should be considered a major threat.

That said Tigers can be operated fairly safely in up to 30 odd kts of wind, perhaps even more, but in these conditions both pilot and (the essential) ground handlers have to be focused and know exactly what they are doing.

Takeoff

The pre-takeoff drills of vital action mnemonic is TTMPFFIIHC, or whatever bits of it you can use anyway. Normally set the trim 2/3 forward.

Look down the centreline of the strip before lining up, as the centreline vanishes as you complete the line-up. Identify a distant directional reference point ahead and as close as possible to the side of the fuselage (the runway edge perhaps) that you can keep in view peripherally out to the side (left normally) to maintain the aircraft parallel to. Then look ahead for a reference in the distance against the side/cowl of the aircraft.

Open the throttle smoothly, a small amount of left rudder may be needed, and hold light forward pressure on the control column (stick) until the tail comes up, then release the forward pressure. Check that the rpm is 1,950 or more, that the oil pressure is 40 to 50 psi, and let the aircraft fly off when it is ready. This will be at around 45 to 50 mph.

Climb at 60 mph. Find a reference point where the horizon cuts the side of the fuselage for climbing and level attitudes. This will involve putting at least part of your face in the breeze. The view directly ahead (unless diving) is negligible to poor.

When safely clear of the ground ease the throttle back until you hear a change of engine note, and continue climb at 60 mph. Weave gently to clear the area ahead.

Crosswind Takeoffs

Apply full into wind aileron. You may do better keeping the stick hard back for a couple of seconds to benefit from the tailskid's help to keep you straight, but once you have 10 to 15 kts of airspeed, if the wind is strong, the limiting factor will become keeping the wings level, not directional control. With two lightly loaded and dihedralled upwind wings, in a three-point attitude, plus a lot of "sail area" up high, plus a narrow track undercarriage, as soon as you start moving in a crosswind the aircraft wants to tip. This can be countered somewhat by getting the tail up high early which reduces the angle of attack (and consequently lift). See the next section.

Lateral Stability on the Ground

Remember, think of the Tiger as two different aircraft types. One when the wind is less than 10 kts, and another when the wind is greater than 10 kts. You may choose to avoid flying in higher winds, at least until you are increasingly experienced and are becoming more comfortable and confident in the Tiger in such conditions.

Because of the Tiger's high CofG and narrow undercarriage, with airspeeds up to about 20 kts the use of rudder in one direction will tend to make the aircraft roll in the other. Above about 20 kts the outside wings (going faster) will develop enough lift to counter this.

If you are compelled (!?) to takeoff in a strong crosswind, there may be some advantage in pointing the aircraft across the runway and therefore more into wind at the start of the takeoff roll. Get the tail up really high as soon as possible to minimise the lift and maximise the aileron effectiveness. As soon as the tail comes up apply full downwind rudder to try and align with the runway. You have the disadvantage now of the faster (upwind) wing wanting to lift. However, it is now at a low or maybe negative angle of attack, and as you turn towards the runway centreline the high CofG should lean you outwards to help counter the effect of the "outside" wing lifting. Full into wind aileron throughout of course.

If the crosswind was so strong that it would have tipped you onto a wingtip before reaching flying speed (e.g. 15 to 20 kts) with a conventional takeoff, then it is probably strong enough to have you airborne (by taking off at 45 degrees off the centreline and utilising some of it as HWC) before you exit the runway edge if you are unable to completely align with the runway once you get going.

Upper Air Handling

The Tiger is lively and pleasant in pitch, neutrally stable in yaw, and the ailerons are there for show only, although they work quite well when coordinated with rudder.

Try using full rudder left and right (skidding) whilst in level flight to get a feel for it. Then try full aileron with rudder locked to see adverse yaw.

Whilst enroute to the training area do a long series of steep turns of 90 degrees left, then 180 right, then 180 left etc., so we keep progressing towards the area. Use FULL aileron, and use it AGGRESSIVELY. This will not come naturally, but it will help you to rapidly develop a feel for when the aircraft is in balance. If you use gentle inputs it will take much longer to develop this feel.

The idea is to keep the "skid ball" (the top needle of the turn indicator) in the middle throughout. The top of the needle works in exactly the same sense as a ball – left needle needs left rudder to correct etc.

You will find it takes a lot more rudder than you are used to, and it will have a different feel – a lot of rudder initially as you bank – then much less as the turn stabilises.

To repeat myself, you will develop a feel for the aircraft much more quickly if you are aggressive, perhaps even a little rough, than if you are gentle. Do several turn reversals watching the needle, then try and do them whilst looking outside and using the seat of your pants to keep the aircraft balanced.

Then try and do the same turns using aileron only, with your feet on the floor. You will find the aircraft will bank about 20 degrees in the direction of the stick, but it will yaw about 30 degrees in the opposite direction, and the rate of turn will be very slow. It will also be very uncomfortable, in the seat of the pants sense.

Whilst you are getting used to the aircraft it is quite likely you will at times inadvertently fly straight and level, but slightly out of balance.

Follow this with wingovers watching the needle, then do the same looking outside and using only the seat of your pants to keep the aircraft balanced. It is important to establish a "feel" for balanced flight as early as possible; the aircraft will not stay in balance with just feet off, let alone hands and feet off, as it is neutrally stable in yaw.

Then try prolonged sideslips (standard approach technique) with throttle closed at 65, 60, 55, & 50 mph. Use full aileron, and rudder to maintain straight track. Getting a GOOD feel for the rudder, airborne and on the ground, is the key to handling a Tiger Moth.

Stalls, spins, aerobatics are straightforward, except that aileron rolls, require the nose to be 30 to 40 degrees above the horizon to start.

Avoid allowing the propeller stopping in flight, however if it does check that the mags and fuel are on, set the throttle 1/3 open and dive vertically to 130 mph minimum to restart the engine.

Then try stalling, power off at first. At a safe altitude, close the throttle, and hold the nose in the three-point attitude until the first symptoms of stall are felt – usually gentle nose or wing drop. Hold the three-point attitude until you have the stick on the aft stop, and then keep it there. The Tiger has a reputation for wanting to spin, but it will only do so if you let it. If you keep the aircraft straight with rudder and keep ailerons neutral, it will just buffet and waffle from side to side a bit. It can't spin unless it has high angle of attack AND YAW. You are in charge of the yaw in this situation – so stay busy with your feet and keep it straight.

Recovery from the stall buffet is instant when you release the back pressure and hence reduce the angle of attack (AOA). There is no need to aggressively push the stick forward, just release a bit of the back pressure.

Now try the same with power on – initially cruise power – then full power. The same applies however it is much harder to keep straight now as the AOA is far higher (well….the attitude is anyway) – and it is far more prone to dropping a wing. Even if it does let go (normally to the right – "WITH" the engine) you can stop it spinning in that direction with full opposite rudder, however if you are still holding the stick hard back, it may well then immediately enter a spin in the opposite direction (i.e. with the rudder) as you now have full pro spin controls – full aft stick + full rudder + full power.

However, if you can stop the nose from migrating in yaw in the first place – you should be able to keep straight (and not spin) for quite a while.

If it does now spin, it will not recover simply by releasing the back pressure. You will have to cut the power, and use opposite rudder.

Next take a look at side slipping. This is, to some degree, the Tiger Moth's substitute for flaps. Like flaps – side slipping allows a steeper glidepath, and better visibility on approach. Close the throttle, and at 65, then 60, then 55, then 50, then 45 mph – try banking one way, and using as much opposite rudder as is required to slip the aircraft in a straight line.

The controls will be crossed, and in theory this is a spin prone configuration. However, you have a nice protection mechanism, i.e. as long as you are slipping in a straight line you can use as much rudder as it takes such that with full aileron, the (opposite) rudder is not overpowering it. That is, in a sideslip to the left with right rudder, the aircraft can only enter a spin to the right – WITH the rudder. To enter the spin, it must yaw and roll to the right first. As long as you limit the rudder to prevent this yaw/roll – the aircraft will not spin, and you can sideslip down to quite a slow speed. If you keep slowing up, the rudder will eventually overpower the ailerons and you will start to roll out of your bank (sideslip) to the left. This is definitely the time to back off – reduce the rudder input and/or increase your speed.

Circuits

The Tiger is often somewhat incompatible with other circuit traffic, as it flies more slowly, and climbs and descends more steeply. Coping with the speed differential is easy - just fly a tighter circuit to "keep pace" with but inside the other traffic. This will also keep you clear of the other traffic - which lessens the chance of them running into you from behind. It also allows you to see traffic in front - since it is displaced from your blind spot directly ahead.

Making an effort to keep track of other circuit traffic is very important since not only do you have blind spots presented by the forward fuselage and the top wings, you also (probably) have poor R/T coms due to the open cockpit. Feel free to yaw, pitch, and roll at any time to "clear" these blind spots if ever in doubt.

You will mostly use the grass runways, and if parallel ops are permitted at your airfield DO NOT DRIFT ACROSS THE CENTRELINE of the sealed runway on climb out. If anything, drift away from it. After a takeoff or touch and go, climb steeply with full power at 60, or even 55 mph. The idea is to climb at a gradient much steeper than the other traffic, so when you get to 500' agl you can turn across the sealed runway centreline WELL ABOVE any following traffic.

Approaching 500 feet have a good look behind (and below) you to clear the centreline, then turn without delay onto a 90-degree crosswind leg, to vacate the centreline area ASAP. If you climb at 80 mph, you will kill your rate and angle of climb, and potentially condemn yourself to doing much larger circuits..... and halve your touch and go rate.

For landing, use the same principle. Turn on to base leg EARLY so you can cross the sealed runway centreline much higher than the other traffic. Make it clear what you are doing over the R/T, and don't hesitate to ask others in front which runway they are using if doubt arises.

A steep approach in a Tiger is better anyway - better visibility in front, and better and more consistent landings than would otherwise result from a long flat approach with a lot of power. To ensure maximum visibility and minimum conflict, make a relatively sharp 90 degree turn onto base. A slow turn may keep traffic ahead hidden below the cowling etc. Fly through the sealed centreline at 90 degrees to minimise your occupancy of the airspace around it.

All of the above demands that you have, and maintain, good situational awareness, and have a good appreciation of the position of any traffic you turn in front of.

The Approach and Landing

Fly final at 60 mph with a little bit of power. Slight sideslip now and again to view/track the centreline, or just stick your head out into the breeze to see where you're going and stay in balance. If high, sideslip to correct. Do wheel landings (i.e. landing on the main wheels only) to begin with. The undercarriage is forgiving and gives a low frequency rebound, generally making it easy to "catch" any bounce. The touch and go is straightforward, but you may need liberal amounts of aileron to keep the aircraft nice and level whilst the wheels are on the ground.

A three-point landing is OK if the wind is calm, OR straight down the runway, OR if the crosswind is very light, say 5 to 7 knots max. Flare until the venturi is sitting on the horizon. This is generally a good reference for the three-point landing attitude.

Keeping straight on the ground by looking out the side (both ion takeoff and on landing) takes a little getting used to, since you can't see DIRECTLY ahead - however if you pick a point in the distance adjacent to the side/cowl it will do fine even though it is displaced from the centreline.

On Approach

A steep approach is better than a shallow one, and usually results in better landings. A steep approach gives you a better view, especially if side slip is employed, and better penetration through wind shear. Since you can side slip off exactly as much excess height as you want, you can always arrive at the flare with the same approach angle and speed as last time. This helps make for consistent landings.

It is more difficult to achieve this consistency with a flat approach with a lot of power - a method that is far more likely to result in what Tiger Moth instructors (and airframes sometimes) hate most - the aircraft flying more or less level at 10 feet or so, nose high, power coming off, speed decaying, waiting for that sinking feeling, and wondering if it is a wheel or a wing tip that will take the first impact!

Instead, you should establish a suitable glide path (approach angle) down towards the threshold AND MAINTAIN IT! You can do this by "bore sighting" - as you would aim a gun. Select a piece of the airframe that is more or less in line with your eyeballs and the threshold - the venturi perhaps, or a bug on the windscreen, and hold it, like the sight of a gun on your target - the threshold.

If the runway starts to migrate above your reference, you are going low, so add power. And conversely if the runway starts to migrate below your reference, you are going high, so reduce power and side slip if necessary. Control airspeed with the stick. The aim is to fly an airspeed stable (60 mph) CONSISTENT ANGLE all the way down to the flare.

So many people seem to fly a lovely stable approach down to a point well short of the threshold, and then at between 150 and 200 feet gradually add power, slowly bring the nose up, and slowly losing airspeed. The result is that instead of arriving at the point of flare with just one job to do, i.e. to manage the flare - they arrive with several. To manage decaying speed, a variable rate of descent, varying power needs, varying yaw with power change, varying touchdown aimpoint. All of which has to be thrown into the blender before they can nut out the "manage the flare" part.

The result is often a firm and uncontrolled flop onto the ground (arrival).

If there is any wind, it is quite likely you will lose a little airspeed through the last 100 feet or so as you enter the friction layer. I.e. there is less (head) wind on the surface than at say 100 feet. Despite what I have just said above, if this happens late in the approach, it is probably easier and less destabilising to simply lower the nose a little to maintain speed and accept a slightly earlier touchdown point, rather than adding power. Steeper is better. And the stronger the wind, the more important it is to maintain your target approach speed right down to the flare.

However though, if the airspeed change is significant, don't hesitate to add power as required.

So do the instructor and the airframe a big favour by arriving at the point of flare AT 60 mph, and WITH a discernible descent angle, and by NOT flying almost level, with almost cruise power, with the nose high and speed decaying.

The Wheel Landing

Both wheel and three-point landings must be mastered. Life will almost certainly be simpler if we start with wheelers, as you will have a better view, better control (more speed plus less AOA), and it requires less judgment of height.

The aim of a wheel landing is to arrive at the flare, perhaps 3 to 5 feet agl or so, AT 60 mph, to close the throttle and gently reduce the descent rate. Allow the aircraft to gently settle onto the ground on the main wheels without too much delay. When the main wheels touch, immediately but gently, ease the stick forward until there is a just perceptible attitude change. The idea is to reduce lift by very slightly reducing the AOA, to discourage the aircraft from getting airborne again. Hold slight forward pressure on the stick as the tail slowly drops.

If it is a full stop landing that you are flying, when you feel the tail skid contact the runway, pull the stick all the way back to KEEP the skid in contact with the ground. Focus on keeping the aircraft dead straight, and counter any rolling tendency aggressively with (probably full) aileron.

If it is a touch and go that you are flying, when the tail skid touches, or when you start running out of runway, maintain the forward stick pressure and smoothly reopen the throttle, countering the yaw to the right and keeping straight with rudder.

Maintain the forward pressure until you are halfway between the three-point attitude and level flight i.e. slightly tail low and hold this attitude until the aircraft flies itself off the runway. Don't bother checking the airspeed indicator, just look out the front, keep the aircraft straight, and maintain an attitude that has you neither trying to plough the runway at 65 mph (nose too low) nor climbing steeply above the three-point attitude.

When safely airborne, select the normal climb attitude, keep in balance, and at your leisure look at the airspeed indicator to confirm the attitude is correct. As for the takeoff, climb out at 60 mph (or at 55 mph if you are in a hurry to climb, and turn across wind at 500 feet agl. Maintain full power until at circuit height, then level off and set between 1850 and 1900 rpm when at circuit speed.

Getting back to the landing. It is possible that at some stage in your Tiger flying career, that you might bounce. Broadly speaking there are three fixes for this.

1. Apply a small amount of forward pressure on the stick, such that when the aircraft returns to earth, it stays there. This works well with a small bounce, may work with a medium bounce, and is not a good idea with a big bounce.

2. After the bounce, DO NOT allow the nose to pitch above the three-point attitude, and/or as the aircraft begins to return to earth, gently raise the nose to the three point attitude (if it isn't there already) AND HOLD IT THERE. This is known as converting a wheeler into a three pointer. It will usually work with small and medium bounces, but is usually a terrible idea with a big bounce. It also can be problematic in medium to strong winds, especially if gusty.

3. Go around. If you have the luxury of a very long airfield, say 3,000 feet or so, you may be able to "go around", but level off at 50 or 100 feet agl and set yourself up for another landing on the same pass.

All this said however, our objective to begin with is to master the wheeler, so we should probably confine ourselves to cures #1 and #3 to start with. To avoid a bounce, it will help a lot if we can achieve a touchdown soon after the flare, before too much speed washes off. So, MAINTAIN 60 mph and a downhill slope right down to the flare. Make an abbreviated flare so that when it is complete, hopefully at about 2 or 3 feet, you still have a slight rate of descent. Closing the throttle fully as you commence the flare will help maintain this rate of descent.

Obviously if you touch the ground with any significant rate of descent, the centre of gravity, aft of the wheels, will drag the tail down and instantly increase the AOA. The higher the rate of descent on touchdown, the higher the instant lift increase. Since the wings were producing almost enough lift to support the aircraft before impact, this instant increase will almost certainly get you climbing again. The springs in the undercarriage will aid and abet this process.

If this firm touchdown and bounce is a consequence of touching down a little firmly at normal, or higher than normal airspeed, then cures 1, 2 and 3 may be available. Because you have speed, you have control.

If however the bounce is a consequence of getting the aircraft too slow - perhaps from holding off too high and/or too long, and dropping it in from 5 or 10 feet or so, then cure #1 is a terrible idea, and #2 is risky also.

So, focus on maintaining a constant glidepath down to the flare, without any levelling off and adding power at the bottom. Also focus on MAINTAINING 60 mph all the way down to the flare. This may mean a slight steepening of descent through the last 100 feet or so. Contradictory? Maybe, but slightly steeper is OK. Flying a level approach at the end is not.

And finally, focus on achieving a smooth touchdown soon after the flare. Don't fly into the ground, but don't hold off excessively either.

The Three Point Landing

Why do them? They are good for short field situations, but how often do you find a runway that is "short" for a Tiger? They are also good for improving your Tiger handling skills, and for this reason should be practised regularly in good conditions. “Good conditions” means light and stable winds, and wide grass runways.

The downside of doing three pointers are poor visibility and less positive control. And on sealed runways you are more vulnerable as the tyres “bite” with any drift, and you have poor to zero tail skid steering. Let’s face it, the Tiger was never designed to operate on sealed runways, so generally avoid them if at all possible.

If you want to keep the maximum distance between yourself and your insurance company, save three pointers for ideal conditions.

Use the same approach technique as for a wheeler, but the throttle is closed, and the flare is begun a little earlier, and continued at a rate that does not cause the aircraft to level off or climb, until the three-point attitude is reached, or maybe even a slightly higher nose attitude than three point. This attitude is then HELD, until the aircraft settles onto the runway. The HELD part is very important.

Don't hold the attitude forever though. If after perhaps five seconds of holding the correct attitude you haven't touched down, it is likely a significant rate of descent will set in. Make some investigations as to how close the ground really is, and if touchdown is not imminent, then smoothly apply full power, countering the right yaw, AND initially maintaining the three-point attitude, and go-around.

Do the same if, having held the attitude for a spell, you get that sinking feeling in the seat of your pants.

All going well though, you will touch down on all three points soon after developing the flare to the three-point attitude.

When you feel the tail skid contact the runway, pull the stick all the way back to KEEP the skid in contact with the runway. Focus on keeping the aircraft dead straight, and counter any rolling tendency aggressively with (probably full) aileron.

If the main gear touches first, a la a wheeler, there is a very good chance you will bounce. Cures #2 and 3 are best. Avoid #1 until you are very familiar with the aircraft. If it is a big bounce though, just go around. This is very cheap insurance!

If you flare too much and the tail skid touches first, it will probably be OK, as long as you get the stick back rapidly to PIN the tail on the ground and keep it pinned. If you allow the tail skid to bounce, it can easily set up a most unpleasant "couple" between the main gear and the skid, helped by rapid AOA changes that can result in violent bounces and wing drop. This normally will only occur if you get the nose way above the three-point attitude prior to tail skid impact. So, don't just continue flaring and flaring and waiting for touchdown as you might in a nose gear aircraft. When you see that venturi on the horizon (three-point attitude), or SLIGHTLY above it, HOLD IT THERE.

The reason "tail skid first" is normally ok is that if the aircraft is sinking onto the ground at a three-point (plus a bit) AOA, it means that even at this "excessive AOA" the wings are producing insufficient lift to keep the aircraft airborne. Otherwise it wouldn't be sinking, right? The first thing to happen after skid impact, is that the nose drops, reducing AOA, and hence lift. So, if there was insufficient lift to fly before skid impact, post impact there is a whole lot less. So, by the time the main wheels touch, in the normal three point attitude, the wings are producing a lot less lift than is required for flight, and so the aircraft will stay on the ground.

Remember, in this situation, when the tail skid touches get the stick back rapidly to PIN the tail on the ground and keep it pinned

The best result you should hope for from your attempted three-point landing is all three points touching down simultaneously. The second-best result is the tail skid touching first, by a hair. The worst result, by a wide margin is the main gear touching first.

Landing Summary

	Advantage	**Disadvantage**
Wheeler:	Hi speed gives good control Good visibility Good touchdown accuracy Good for landing on seal	Hi speed gives bigger bounce Slightly longer landing
Three Pointer:	Shorter landing Less speed for (big) bounce	Much less control More vulnerable to gusts Higher chance of a bounce Harder to recover from a bounce Terrible for landing on seal

Most runways and airstrips these days are very long compared to a Tiger’s needs, so the three pointer has little to recommend it in my view. Having said that, we should all remain current and competent with three pointers, and I seldom miss an opportunity to do one, but only IN IDEAL CONDITIONS.

Crosswind Landings

For crosswind landings, and in fact all landings - you have a lot more control when you wheel the aircraft on (plus less turf damage). The only benefit of a three pointer is a shorter landing.

However, crosswind landings can be done “two point” i.e. upwind wheel + tailskid), but if you touch down with any rate of descent (i.e. drop it on from a couple of feet) the “impact” will make the aircraft rock onto the downwind wheel, and probably further - so now you are low speed, virtually no aileron control, with the downwind wing dropping. You also have the momentum of quite a high CofG (with the top wing, tank, etc.) also pulling you over the wrong way - can be quite uncomfortable.

Once tailskid has “landed” pull the stick fully aft to prevent bunny hopping, and to maximise “braking”.

Shutting Down

Bring the aircraft to a stop and if it is the last flight of day, switch the fuel off and allow the engine to idle for 2 to 3 minutes. Carry out a dead cut mag check (important), and when the time is up, switch the mags OFF and open the throttle fully to prevent running on.

If there are more flights to do, carry out the actions as above but do not turn the fuel off.

Post Flight

Find a large rag……

TIGER MOTH AEROBATICS

I was recently asked to provide some notes on Tiger Moth Aerobatics to be used as an appendix to a Warbirds aerobatic training syllabus. As I wrote these notes, I was constantly aware of a feeling of “well, this is how I do it, but what is the correct or ideal way….?”. I have never seen any formal notes on Tiger aerobatics.

The following represents most of what I know about aerobatics in the Tiger. The vast majority of it has been taught or shown to me by others, or has been pinched from Neil Williams’ book on the subject. I think it (my brief, not Neil’s!) is probably flawed in places, and it certainly is not supposed to be authoritative. My reasons for presenting it here are mostly selfish – I would like to increase my knowledge of the subject. So, I am inviting criticism of, and additions to, what I have written below. “Additions” includes alternative ways of skinning the cat.

In particular I would be keen to hear from people who grew up with Tigers, as they probably have clearer and purer recollections of the original way of doing things. Also, knowledge of or anecdotes about flick manoeuvres, bunts, inverted spins and inverted flying are most welcome. For example, some flight manuals prohibit bunts and outside loops – but one of Alan Cobham’s Tigers did 1500 or so of them in the 1930’s.

So, if you have anything to offer on the subject please e-mail/fax/phone John King and myself. Hopefully what we’ll end up with is a forum/discussion via the Cyber Moth, where all and sundry can pick and choose whichever techniques they like best.

David Phillips david@jdphillips.co.nz 021 384 225

Aerobatics in a Tiger Moth

The aim of this brief is to provide a simple and basic guide to aerobatics in the Tiger Moth. To keep it simple some of the suggestions do not represent text book or competition style techniques, but rather just an easy way of getting the job done with minimum height or energy loss for someone who is new either to aerobatics or the Tiger Moth. For example, the section on looping will give you a loop that is straight, and (importantly in my view) comfortable to the pilot and passenger, but will be egg shaped rather than perfectly round.

To begin with, some explanations:

1. “Top Rudder” is rudder applied for the purpose of preventing the nose from dropping in relation to the horizon. For example, consider a 360-degree roll to the left from wings level, an application of Top Rudder would involve right rudder for the first 180 degrees of roll, and left rudder for the second 180 degrees.

2. Use of Rudder. The secondary effect of rudder is roll. Right rudder produces right roll, but only when positive G is applied. If you are flying straight and level and push to minus 1 G, and then apply right rudder, the aircraft will roll left. This is of course due to the negative angle of attack. Logically then rudder with 0 G should produce no secondary roll. This is almost true – but for the Tiger with its dihedral there may still be a slight effect.

This “variable” G dependant secondary effect is of significance with all rolling manoeuvres, and the Stall Turn.

As Neil Williams says in his book “Aerobatics” (from which a lot of what follows has been taken): “The misuse of rudder causes nearly all the minor problems in aerobatics….”

Overview

The Tiger Moth is lively and responsive in pitch and yaw (elevator and rudder) but is lethargic in roll (aileron response). Consequently, it is good for manoeuvres like loops, spins, wingovers, and stall turns, but requires some finesse with rolling manoeuvres. Even the barrel roll, which can almost be regarded as a crooked loop, takes a moderate degree of skill to complete satisfactorily.

Before practising solo aerobatics in a Tiger, the pilot should be proficient in spin recovery. He/she should also be proficient at recovery from nose high/zero airspeed situations and the frequent consequence of same – the windmill engine restart after the propeller has stopped moving.

Despite its appearance the Tiger is very robust due to efficient structural design. The highest risk of damage from aerobatics comes from the low speed/nose high situation, and from excessive G loading at high speeds.

Low Speed/Nose High

The elevators and rudder in particular are very large, and can be damaged if a tail slide of any significance develops. To prevent this the pilot should try to avoid getting the aircraft “hung up” or stopped in a vertical climb attitude. Avoidance of this can be achieved even at very low speed by firm use of “up” elevator with full power applied. This will keep at least SOME positive loading on the aircraft until the last moment which in turn will keep the gravity fed engine running, which will give you some elevator and rudder effectiveness even at zero airspeed. Use these controls to get the nose through or away from the vertical.

Full power will also impart maximum rotational momentum to the prop, so if the engine does later stop due to lack of gravity feed, the prop is more likely to keep rotating for long enough to re-establish fuel feed and/or a nose down accelerating situation which will allow the prop to windmill and continue turning.

If you push forward on the control column significantly whilst in or close to a vertical climb, the engine will stop instantly, after which you will have little or no control until the nose falls through – in whatever fashion – to a steep nose down attitude. Any time you find yourself approaching zero airspeed with the aircraft in a near vertical attitude AND with the engine at low or zero thrust, it is vital that the controls – elevator and rudder in particular – be held neutral with all your strength. This will minimise the likelihood of damage due to a tail slide with a “controls hard over” situation developing.

High Speed

Not a term you hear used much with respect to Tiger Moths – but it can be done. Vne is 160 mph, and anecdotal evidence from a 1950's era ag pilot suggests the terminal dive velocity (full power) is 230 mph. This figure is verified by some Type Record archives unearthed by Keith Trillo.

Any time you exceed even 130 mph during aerobatics in a Tiger you are probably just giving away height and performance for little gain – a necessary evil when doing a Roll-off-the-Top with its 135 mph entry speed. Another occasion when you may see speeds above 130 mph is when you are performing a windmill engine start. Be VERY gentle during the ensuing dive recovery. According to Keith's Type Records "Summary of Load Factors" the structure is good for 7.5 G at the stall, but is only good for 1.5 G at 235 mph. (I am surprised it is good for anything other than fire wood at this speed!)

An accident report - also unearthed by Keith - regarding wing failure on a Tiger in the Waikato in the late 1950's suggests by interpolation of the Type Record figures that the structure would only be good for 4G at 140 mph. It is very, very easy to exceed 4G at and above this speed as most Tigers will have a strong nose up tendency even with the trim fully forward. Having said that, the only instances of catastrophic structural failure that I have heard of have resulted from either rotten wings (such as in the case above) or mismatched threads on the flying wire fork ends.

Preflight

Ensure the aircraft is at or below the max weight for aerobatics (1770 lbs), and that there are no loose or heavy objects in the baggage locker. Ensure your harness is as tight as you can possibly make it – especially if it is an original Sutton Harness. After the first loop the seat cushion will compress, and your straps may feel loose again. If possible obtain a very firm seat cushion or a parachute to minimize this effect.

Also, with the Sutton harness, ensure once strapped in that there is no possibility of the top of the control column fouling the piece of string that attaches the harness locking pin to the RH shoulder strap. This can happen if the string is too long – forward stick can then catch the string and pull the pin out, especially during a slow roll. This I believe is the reason that the RNZAC "D.M. Allen Memorial Trophy" (for aerobatics) has the "Memorial" part in it!

Airborne

Complete the HASELL checks as usual. Then set full power and enter a gentle dive and keep accelerating until you reach the limiting engine RPM. This will vary according to which version of Gypsy Major engine is fitted, and what the pitch of the prop is. For most Tigers limit RPM of 2350 or 2400 occurs with full throttle at about 120 mph. Assuming the limit for your particular engine/prop combination is 120 mph – then at any time your speed is equal to or less than this, you can use full throttle and be confident without reference to the Rev Counter that you are not over speeding the engine. Above 120 mph, you will have to throttle back to maintain the RPM within limits.

Basic Handling Exercises

Apply full power and pull the nose up to about 45 degrees above the horizon, and try to hold it there as the aircraft slows. You will end up with the stick fully aft and the nose trying to break left or right with an associated wing drop. With deft use of the rudder only, you will be able to keep the wings level to within about 20 degrees or so for quite a while, with the aircraft tracking more or less in a straight line. There will be considerable buffeting. The key is to prevent any yaw developing, as without yaw a significant wing drop will not occur (on my Tiger anyway!). The objective is to develop a good feel for the Tiger's low speed habits, and rudder use in particular.

Now resume normal level flight and have a good look at the slip needle (top half of the turn and slip indicator) and become comfortable with what it is telling you. In straight and level flight with cruise power, smoothly apply half or two thirds left and right rudder whilst keeping wings level to become familiar with how the aircraft feels with significant rudder deflection, and to observe the slip indications. Then try full left and right aileron whilst keeping the rudder central, and note the same.

Next, try a series of steep turns and reversals – 60 to 80 degrees bank angle - using FULL aileron to enter the initial turn and FULL aileron for the rapid reversals from left to right to left etc. The objective is initially to keep the slip needle more or less centred throughout, and then later to be able to do the same without reference to the slip needle.

The overall aim is to develop a good "seat of the pants" feel for when the Tiger is in balance, and a feel for how much rudder is required to balance large aileron inputs and turn reversals.

Wing Over

This is an excellent manoeuvre to develop coordination and a feel for the aircraft. Apply full power, dive gently to no more than 110 mph, followed by a pull up to approximately 45 degrees above the horizon, followed by a roll of between 90 and 110 degrees angle of bank. Allow the nose to fall thru the horizon to approximately 45 degrees nose down gently rolling to wings level as it does so. Recover from the dive and pull up again to repeat the exercise in the opposite direction.

Minimum indicated airspeed at the top of the manoeuver may vary from 60 mph down to zero. There should be very little "G" felt at the top of the manoeuvre, as you "float" over the top. Of course, if you only have 20 mph IAS at the top, you will not be able to pull much G without stalling. The reason the aircraft can still "fly" at 20 mph is that the loading on the aircraft is way less than 1 G at this point.

You know you are "Wing Overing" properly when the aircraft stays in balance throughout, and when the manoeuvre feels smooth and comfortable throughout - no sudden changes of G loading, no feeling as though you are falling to one side of the cockpit or the other, and no negative G or falling sensation with the resulting instant engine (but not prop) stoppage.

When you are comfortable with the Wing Over, you can experiment with gentle forward stick inputs at the top of the manoeuvre to determine just exactly how much 0 G or slight negative G the engine will tolerate before it cuts out. This will be useful in subsequent manoeuvres – the loop and stall turn in particular – where you might want to make the manoeuvres more rounded or more vertical but without losing power when you do so.

The Loop

(For this and all other "high speed entry" manoeuvres, trim for full power and no less than 90 mph).

From straight and level flight, apply full power and dive gently (approximately 20 degrees nose down) to the 115 mph entry speed. Then press the stick smoothly back to achieve a good rate of pitch, ensuring that the aircraft remains in balance (slight left rudder req'd as the speed drops) and that the wings remain level. As the nose rises well above the horizon transfer your scan to both wingtips and their adjacent horizons to monitor your wingtips as you progress around the loop.

Keep a slight amount of positive G on over the top of the loop otherwise the engine will stop. The objective here (initially anyway) is not to make a perfectly round loop, but rather to make a perfectly comfortable (probably egg shaped) one. As you get to within 30 degrees (or so) of inverted referenced from your wingtips look towards the front again, looking over the top of the fuel tank – to find the horizon again and to ensure that the wings are level. As you accelerate down the back side of the loop, increase the G loading so as to bottom out at the same speed and altitude as at entry. Slight right rudder may be required as the aircraft accelerates. Continue with the back pressure until the nose is 20 degrees or so above the horizon to conserve energy, and level out when the speed is back at approximately 90 mph. Remain at full throttle throughout.

The Stall Turn

It is important to ensure that the engine does not stop due to fuel starvation during this manoeuvre, as good rudder authority is essential. So, don't pull up beyond the vertical, or "push" once the vertical is attained, as either of these sins will result in fuel starvation and engine stoppage – with the possible consequence of propeller stoppage, and quite possibly an off field landing!

Additionally, it requires significantly more skill to stall turn to the left than to the right, due to the effect of slipstream from the engine.

For these reasons I suggest that during the early stages, and until familiarity is gained, that all stall turns are done to the right, and from a pitch attitude of slightly less than vertical. And **ALWAYS** have sufficient altitude available for a Windmill Start. My first Tiger Moth ended up in a paddock twice as a consequence of ignoring these rules. No, I don't have a learning disability – the second time I was watching from the ground!

The stall turn can be completed from level flight at cruise power, however using the same entry parameters as for the loop – 115 mph - will allow more time to achieve and assess the vertical climb. This is important. As with the loop, remain in balance and keep the wings level – failure to do so will result in ending up pointed to the left or right of vertical, and the turn at the top will be more difficult if it is opposite to the bias you have allowed to creep in.

Rear seat references - when your flight path is exactly vertical the top surface of the bottom wing tip area will appear to be at or very slightly over 90 degrees to the horizon (taking into account the positive incidence of the wing (rigging angle) and the curvature of the aerofoil. It may be easier to reference from the top of the cockpit door which should be just short of vertical, however due to your line of sight you cannot view this directly against the horizon.

From the front seat, the spear at the flying wires intersection makes a good reference – at or slightly over the vertical. The top of the cockpit door may also be used.

As with the loop – pull up smoothly to the vertical using the same references and remaining in balance, and ensure you are not “one wing low”. When you get to the vertical (or as close to it as you want/dare) ‘check’ the stick to STOP all movement in pitch. Ensure that the top surfaces of the lower wings REMAIN at (close to) 90 degrees to the horizon. If you allow even a small pitch rate to continue, the aircraft will roll as it yaws over the top of the manoeuvre and your exit will not be 180 degrees out from your entry.

This roll is caused by the secondary effect of rudder due to the slight positive angle of attack resulting from the pitch rate. This is a very common error, often caused by the pilot being in a hurry to “get out of the vertical” due to the rapidly decreasing airspeed indication.

Resist this temptation. For an ideal stall turn there should be a well defined vertical track AFTER you have stabilized in the vertical, and BEFORE you start the turn.

Stall turn RIGHT (‘with’ the engine)

Ideally, we should wait until the aircraft comes to a stop before applying full right rudder. With practice this point (zero airspeed) can be sensed without looking inside the cockpit. The vibration changes subtly and there is a sense of the prop “cavitating”. If you are reluctant to wait this long, then the point at which the airspeed decreases through 40 mph is a good reference. Apply full right rudder, and the aircraft should pivot on its axis, and the nose should cut through the same piece of the horizon that the right wingtip was previously on, with the left wingtip doing likewise soon thereafter. As you go over the top of the turn, keep the wings vertical with the ailerons.

Once the nose is below the horizon, the yawing momentum will tend to swing the nose to the right beyond the vertical down line, and this should be opposed with coarse left rudder to stop the aircraft exactly at the vertical.

Leave full power on throughout. As the speed increases, and after you have established a vertical track downwards, gently ease out of the dive and raise the nose above the horizon as per the exit from the loop to conserve energy.

When comfortable with the basic workings of this manoeuvre, focus on getting the aircraft exactly vertical to begin with.

Stall turn LEFT (‘against’ the engine)

This can easily turn into an equal competition between the left-yawing force of the rudder, and the right-yawing force of the slipstream. We can help the rudder slightly in this competition by using it slightly earlier, and by reducing power somewhat at the same time. Decelerating through 50 mph in the vertical, briskly apply ½ left rudder, and as the nose starts to yaw reduce power by about half. As the nose continues to yaw, feed in more left rudder and progressively further reduce power.

The idea is to get the nose moving left and to keep it moving. Once it has gone past 45 degrees or so gravity helps significantly and slipstream becomes less relevant. Again, use coarse (right this time) rudder to prevent the “over swing” on the vertical down line, and smoothly reintroduce full power before pulling out.

If you use too much rudder too early on the vertical up line, the yawing force produced will be opposed and balanced by the "stabilising force" of the airflow (i.e. NOT engine produced slipstream) acting on the fin and rear fuselage. This will result in a stable (non-yawing) upward sideslip. Yawing momentum is lost, and the aircraft may well become "hung up" with the nose 15 or 20 degrees left of the vertical.

Gravity eventually prevails, and if the pitch attitude is less than 90 degrees, the aircraft will tend to pitch forward (negative G) starving the engine of fuel. If the aircraft was sliding backwards immediately prior to this, the chances of propeller stoppage are high. For this reason, it is more important to have the aircraft tracking exactly vertically to begin with.

To summarise

The stall turn right is relatively simple, as the rudder and slipstream act together to yaw the aircraft thru 180 degrees. This powerful yawing combination allows an "acceptable" stall turn from as low as 70 degrees nose up – 20 odd degrees before the vertical. The stall turn left however relies to a large degree on gravity to "pull" the nose around. If the attitude is significantly short of the vertical, then the aircraft will simply pitch forward in a very messy manoeuvre.

The name "stall turn" is actually inappropriate as the aircraft should not stall. The angle of attack should remain at zero and never get anywhere near the 15 degrees stalling angle. The American term "Hammerhead" more accurately describes the manoeuvre.

Rolling Manoeuvres

These are quite a challenge in the Tiger, as the ailerons are not particularly powerful and can easily be overpowered by the secondary effect of rudder at low speeds.

Aileron roll

Because the roll rate is so slow, it is necessary to get the nose well above the horizon before starting – otherwise you will end up with a very nose-low exit. However, it is also necessary not to get the nose too far above the horizon, otherwise you will get too slow, which in turn will markedly lower the roll rate – and you will again end up with a very nose low exit. Unfortunately, these two requirements overlap, and the only antidote is more speed on entry.

Dive to 115 mph with full power, and then pull the nose up to between 25 and 30 degrees above the horizon. STOP the pitch rate i.e. removes any elevator input, then apply full aileron and just a touch of rudder to balance. The objective from here on is to achieve a maximum rate of roll with a minimum of nose dropping below the horizon. Return the rudder to central by the 45-degree point, and as you go past 90 degrees start easing the stick forward as much as you dare without stopping the engine. Note: in my experience the engine is slightly more tolerant of zero or slight negative G whilst in the horizontal (rolling, pushing etc.) than in the vertical (i.e. stall turn entry).

The goal here is not to hold the nose on or above the horizon as with the slow roll, but rather just to limit the amount by which it falls. In this way hopefully we can keep the engine running throughout.

Once you go past the inverted position you can ease off on the forward stick and start introducing top rudder (i.e. if rolling right, then right rudder and vv?????). Top rudder will further limit the "nose drop", and will substantially improve the roll rate thru the last 90 degrees to wings level again.

This is not a “Tiger friendly” manoeuvre, and don’t be surprised to see very nose-low exit attitudes, especially if you keep some back pressure on the stick throughout.

Barrel Roll

Perhaps the barrel roll in the Tiger is best thought of as a “crooked (or offset) loop”. The main challenges here are to:

1. Get the nose sufficiently (very) high during the first part of the manoeuvre;
2. Sustain a reasonable roll rate across the top of the manoeuvre when airspeed is very low; and,
3. Avoid “burying the nose” during the third quarter of the roll.

There are two gates: – the aircraft should be wings level (momentarily) as the flight path (not the nose – the flight path!) of the aircraft cuts the horizon pulling up at the start of the roll, and wings should be level when the flight path cuts the horizon half way (inverted) through the roll. This translates to a normal level attitude at the start, and (approximately) the point at which the horizon appears under the bottom of the fuel tank when inverted. If you wait until the nose cuts the horizon inverted, you will already be going downhill rapidly and will probably lose a lot of height.

Barrel Roll Right

Start as for a loop by diving at full power to 115 mph, simultaneously turning 45 degrees left away from the desired roll axis. On reaching 115 mph, pull up and commence a gentle roll to the right, balancing with rudder. As the flight path pitches upwards through the horizon the wings should be passing through level. Initially we want to get a lot of pitching done without too much rolling, as we want to get the nose at least 45 degrees above the horizon by the time we get to 90 degrees of roll. After passing 90 degrees of roll, any back pressure on the stick will pull the nose down and sacrifice height – so release most of this pressure and allow the aircraft to “float” inverted over the top at close to zero G. The airspeed will be dropping so after the 90 degree point you will probably need to increase aileron deflection to the maximum to keep a reasonable roll rate going.

Roll rate can be enhanced at the low speed achieved at this point by applying rudder in the same direction, however this will only work with more than zero G applied. This in turn requires more back pressure on the stick whilst inverted which in turn leads to burying the nose – so it is a trade-off between roll rate required and the resulting lower attitude.

After passing the inverted, the nose will drop, and the aircraft will start to accelerate again, and the roll rate can be managed again by ailerons only. Our priority now is to complete the roll without the nose dropping too far. As the wings go past the 135-degree point (5/8ths of the way through the roll) start applying top rudder to prevent the nose from dropping too far. This will also increase the rate of roll, especially during the last 90 degrees of roll, so it may be necessary to reduce the aileron input slightly.

Upon reaching wings level, pull the nose up again to 90 mph to conserve energy. To picture the “geometry” of the manoeuvre, imagine yourself flying along in the middle of a giant baked beans can that is lying on its side. You make a diving 45 degree turn away from the centre axis of the can, and then pull up and make a corkscrew roll in the opposite direction - around the axis - with your wheels just brushing the interior surface of the can. When you reach wings level again, pull up to the centre axis again.

Cuban 8 (also called a Horizontal 8)

Commence as for a loop, but STOP the nose from pitching when you are 5/8ths of the way through, i.e. when you are inverted diving at 45 degrees. Reference this 45-degree nose down attitude from the lower wingtip(s) against the horizon. Now look through the centre section struts and the front windscreen to a reference point on the ground, and HOLD it there for a couple of seconds to allow some acceleration (= more aileron effectiveness).

Holding this "sight picture" briefly will ensure you have STOPPED any pitch rate (some forward stick is required) which is important to prevent "barrelling" of the subsequent roll. Now roll to upright using full aileron and NO rudder. When you are at the 90-degree point, you can use top rudder (which will now assist roll) to help keep the nose fixed where you want it. Upon reaching wings level, maintain the 45-degree nose down attitude until you again reach looping speed (115 mph) and repeat the exercise to complete the "8". If you are not remaining "straight" with respect to your ground reference points it is very likely due to unwanted elevator input during any part of the roll, or due to rudder input during the first ¼ of the roll (from inverted to 90 degrees angle of bank).

Slow Roll

Prior to starting out with this manoeuvre it is a good idea to first just get comfortable – if that is possible – with being upside down in level flight in a Tiger. Finding a hard seat cushion will help a lot here, as if you have done any positive G manoeuvres on a soft cushion it will compress and your straps may have become loose. The sensation of subsequently "falling into them" as you roll upside down is most unpleasant. During the preflight it is worth experimenting with how to get full aileron travel, this is more important if you are tall, as your knees can prevent you from getting full travel, especially with right aileron. It may be necessary to try and "hide" your knees, and perhaps hold the very top of the stick to get more freedom of movement.

The major challenges are to keep the nose from dropping below the horizon, and to coordinate rudder and aileron use to maintain a constant rate of roll. Significant deflections of top rudder are required, which will oppose the roll for the first and third quarters, and help it for the second and last quarters.

Consider initially doing this manoeuvre with the elevator trim fully forward, to help keep the nose up whilst inverted. "Pushing" is a much less natural control input than pulling, and if you have to use a lot of forward stick force it will be difficult to be precise with the ailerons.

It will be slightly easier to roll right "with" the engine.

Having achieved an entry speed of 115 mph, pull up to 15 degrees above the horizon, and apply full aileron with a touch of rudder to balance. As the roll progresses through 45 degrees, gently begin to reverse the rudder to hold the nose up. After you pass 90 degrees this "top rudder" will increase the rate of roll, so slightly decrease aileron deflection and start easing the stick forward to keep the nose above the horizon. As soon as the engine cuts, retard the throttle to idle.

Passing through the wings level inverted position the nose should still be above the horizon. You will now need to smoothly reverse the rudder so that it remains "top", but do this carefully and minimally, as it is now opposing the roll rate at a time when the airspeed is low and decreasing. You will need full aileron for this phase. Approaching the 270 degree point you will need a significant amount of top rudder to keep the nose up whilst the airspeed is steadily decreasing. Do not use so much that the roll stops, and if necessary allow the nose to drop slightly.

For the last quarter, the aircraft will be quite slow, and you may well need neutral or opposite aileron (against the direction of roll) to counter the powerful rolling effect of the top rudder. Open the throttle slightly as you pass the 270-degree point, and as soon as the engine responds smoothly advance to full throttle.

As Neil Williams says – “the rudder should be used to delay/minimise the nose drop, not to stop it completely”. If you use a lot of rudder, you will simply end up side slipping, which is a very effective method of reducing speed and energy.

The roll should start with the nose about 15 degrees above the horizon, but do not expect to keep it there, especially after the engine stops. Expect to exit the slow roll with the nose no lower than 10 degrees below the horizon. Also (Williams), the nose will wander slightly to the left and right during the roll, but should end up on the same heading as upon entry.

The first objective should be just to complete the roll with the nose not dropping too far beneath the horizon, and remaining on an approximately straight track. Once this has been achieved, you can experiment with varying the aileron to keep a constant rate of roll throughout. This will involve less than full aileron deflection to begin with, full deflection by the 90-degree point, backing off until inverted, then full deflection to the 270 point, and then backing off to neutral or even opposite aileron to counter the powerful rudder.

Roll off the Top

With full power dive steeply to 135 mph. Passing approximately 120 mph you will need to throttle back somewhat to stop the engine from over speeding. Upon reaching entry speed, pull up smoothly (do NOT jerk the stick back) into a fairly tight loop. As the speed decreases through 120 mph reestablish full power. Use the same visual references as for a loop. As the aircraft reaches the level inverted attitude (bottom of the fuel tank on the horizon) smoothly ease the stick forward to hold this attitude, and hopefully the engine will keep running for a second or two.

Then complete the second half of a slow roll. If/when the engine stops, close the throttle.

Your airspeed will be low, so it is necessary to get FULL aileron in as soon as you can to get the aircraft rolling. Keep the rudder locked neutral initially. You will soon need top rudder to keep the nose on or above the horizon but be cautious with this as it will be opposing aileron input until you reach the 90-degree point.

If the engine has stopped due to negative G, open the throttle slightly passing the 90-degree point, and when the engine responds, open the throttle fully. It is easier to roll to the right “with” the engine, but make sure you are applying FULL aileron and that the top of your right (stick) hand is not restricted by your right knee.

Like the stall turn to the left, practice of the Roll off the Top may well result in a stopped propeller. Review the Windmill Start procedure and think about paddocks below and adjust your entry height accordingly.

Spinning

Spinning the Tiger is conventional in all respects. Entry from level flight can be achieved by closing the throttle and slowing the aircraft to about 45 mph (i.e. just above the stall), and then smoothly applying full rudder in the desired direction of spin. As the yaw begins, bring the stick smoothly and firmly all the way back to the aft stop, and keep it there. The nose will drop smoothly to a steep nose down attitude and the aircraft will stabilise in a comfortable and stable spin within ¾ of a turn.

The best outside reference is straight ahead between the centre section struts (under the fuel tank), as looking for the horizon above the wing will involve lifting your head significantly – probably not a good idea during a spin.

Recovery involves applying FULL opposite rudder, and then moving the stick smoothly and centrally forward – usually to about half way between neutral and full forward. As soon as the rotation stops smoothly centralise the rudder, and recover from the ensuing dive. As the nose approaches the horizon, increase the throttle to cruise power.

The rate of turn (spin) will accelerate briefly as the nose drops during the recovery – same physics as for the spinning ice skater who pulls in her arms. The spin should stop within one turn, and recovery can be even quicker with more aggressive use of forward stick.

Flick Roll

This manoeuvre is pretty hard on a Tiger, so consequently is NOT recommended. However, you can do an "accelerated spin entry" from between 65 and 70 mph without doing too much harm. It is a convenient way of initiating a "roll over and pull through".

From level flight and 60 mph, open the throttle fully. Accelerating through 65 mph, pull the nose up firmly whilst smoothly applying full right rudder. The aircraft will smoothly and gently "flick" to the right. Approaching the inverted centralise the rudder and release the back pressure momentarily. As the aircraft unstalls it will stop rolling – hopefully exactly in the inverted attitude – and you can then simply complete the second half of a loop to recover. If the spin continues CLOSE THE THROTTLE and recover.

The Flick Roll can be continued level through 360 degrees, but you will have to apply opposite rudder and stick forward a good 40 to 60 degrees short of wings level to stop the roll at the very low speed you will find yourself at. It is very hard (for me anyway) to stop this roll with any sort of precision as the aircraft is very slow on exit.

Reducing power may also help to stop the (partly torque induced) rotation to the right. The aircraft will recover much more cleanly from a roll to the left (against the engine) and there is no need to reduce power – however significantly more "violence" will be required to get the aircraft rolling that way in the first place.

More energy can be saved, and a quicker roll rate achieved, by easing the stick forward significantly after the flick has started – maintaining full rudder deflection. The real answer to the lack of energy when exiting the roll is to start with more of it in the first place. Williams recommends 2 x the stall speed (90 mph) less 5 mph for safety = 85 mph for a Flick Roll. But you can feel the aircraft "working" when it flicks at this speed, and you will probably be reluctant to continue unless the aircraft is Government Property.

Falling Leaf

This manoeuvre consists of a consecutive series of incipient spins. From straight and level flight, close the throttle and wait for the aircraft to stall. As the stall occurs apply full rudder, and the nose and wing will drop. As soon as the wing drops apply full opposite rudder; the yaw should stop within 45 degrees or so, the nose will rise slightly (since the stick should still be fully aft), and then the other wing will drop. Immediately apply full opposite rudder etc. etc.… and keep repeating the cycle for as long as you want. Recovery occurs instantly when you push the stick forward, since you already have (for 99.9% of the time anyway) anti-spin rudder applied. Decide in advance upon an exact height to begin recovery, as it is easy to become “tied in” to the cycle and to attempt recovery with rudder only. You MUST push the stick forward to break the cycle.

In Neil Williams’s book the technique includes releasing the back pressure with each rudder reversal to momentarily unstall the aircraft. This probably does result in the true falling leaf – with more pitching and more “leaf like” behaviour. However, if you are a nanosecond slow with your timing, or maybe even if you aren’t – the speed will tend to increase between cycles and the result can be quite a violent flicking reversal.

Keeping the stick fully aft throughout will keep the speed back and the manoeuvre gentle and predictable.

In Flight Engine start (or Windmill Air Start)

The need for this procedure is most likely to stem from running out of speed with the nose above 60 degrees or so of pitch. It is more likely to happen if the engine is at idle either due to throttling back, or due to fuel starvation as a consequence of negative G. For example, after falling out of a stall turn to the left (against the engine torque etc.).

For practice purposes we first need to stop the engine. Start from a height of AT LEAST 3000 feet agl, preferably above an airfield or an area suitable for a forced landing if the worst comes to the worst. Throttle back to idle and pull the nose above the horizon, select ONE set of mag switches to off, and immediately open the throttle fully (same as for engine shutdown on the ground). Hold the aircraft at or close to stall speed, and wait for the propeller to stop.

With the prop stopped, establish a glide at 60 mph, and check:

1. Fuel Selector ON;
2. Throttle set 1/3 Open; and,
3. Magneto switches (the ones that were turned OFF!!!) back ON.

Smoothly and without delay lower the nose to AT LEAST 70 degrees nose down, and preferably to the vertical. Do not reduce the dive angle until the prop starts turning, and then GENTLY ease out from the dive. If you were trimmed for cruising speed before starting this exercise, you will find yourself “pushing” during the recovery to stop the nose from pitching up too rapidly with the consequent excessive G.

How long you need to remain in the dive and the airspeed at which the prop starts turning depends on a number of factors including: the pitch of prop, how tight the engine is, which compression the engine stopped on (weak or strong one?) and length of time the turning force is applied to the prop.

I.e. you might have to dive for three times as long with a 45-degree dive angle as you would for a vertical dive. Continue the dive until the propeller is rotating freely. I have seen it go through one compression and then stop again.

Be very careful easing out of the dive. You will do the aircraft far less harm by over speeding the airframe slightly due to a relaxed pull out, than you will by doing an aggressive pull out at high speed. Having said that, on a well run-in engine the prop will start turning before 120 mph indicated, so completing the start and recovering from the dive should be easily possible without exceeding Vne of 160 mph.

Finally

Many of the manoeuvres described above can be completed at slower speeds. I have used 115 mph for many as a simple “one size fits all” – easier to remember etc. However, the slow roll entry is often quoted as 110 mph, and it can be done slower. A light Tiger will loop from 100 mph, and the stall turn can be done from straight and level cruise – you just have less time to establish an exactly vertical climb.

To quote Jim Rankin: “Between manoeuvres, anytime you are flying at a speed greater than the full throttle straight and level speed of your aircraft, you are giving away energy”.

It follows from this that the best way to conserve energy between manoeuvres is to fly at your best rate of climb speed. Continuous aerobatics in a Tiger means continuous height loss, so I suggest whilst practicing technique, finish each manoeuvre with a 65 mph climb, and maintain this until you are ready for the next manoeuvre. You will save a lot of time and energy this way.

If you are practicing for the Tiger Club Aerobatics competition however, you will need to have a level flight segment before and after each manoeuvre, and ideally you should not climb or descend between manoeuvres. Height is sacrificed to preserve geometry.

Limitations

Max Engine RPM:	- 2400 Gypsy 1C - 2350 Gypsy 1 & 1F
Min Oil Press:	30 psi
Max Oil Press:	60 psi
Airframe:	+6G - 3G (More than you will ever need, +ve or -ve!)